Sl. No. : 0033

MP-1.4

Total No. of Pages : 2

I Semester M.Sc. Degree Examination, July/August - 2019
(SLM Scheme)
PHYSICS (Course - IV)
Solid State Physics and Electronic Devices

Time : 3 Hours **Max. Marks : 80**

Instruction : ***Answer all questions.***

1. a) Define reciprocal lattice. Obtain the expressions for reciprocal lattice vectors. **[10]**

   b) Deduce the expression for Bloch function. **[5]**

OR

2. a) Using the tight binding approximation, show the formation of energy bands in a simple cubic crystal. Also show that for small values of k, electron will behave like a free particle. **[10]**

   b) For the Kronig-Penny potential with P<<1, prove that the energy of the lowest energy band at $k = 0$ is $E = \frac{h^2 P}{4\pi^2 ma^2}$. **[5]**

3. a) Write a note on Boltzmann transport equations. **[5]**

   b) Describe Umklapp scattering with a neat diagram. **[5]**

   c) A photon undergoes Compton scattering by an electron at rest. If the energies of incident and scattered photons are 0.46 MeV and 280 keV respectively, find the angle between them. **[5]**

OR

4. a) Explain briefly about **[10]**
   i) Anomalous Skin Effect
   ii) Schottky effect

   b) Calculate the plasma frequency and dielectric constant of copper for wavelength of 640 nm. Given: free electron density = $2.66 \times 10^{28} m^{-3}$. **[5]**

5. a) What is meant by radiationless transition? Arrive at the expression for intensity in case of both temperature dependent and temperature independent luminescence. **[10]**

   b) Discuss Franck-Condon Principle with a neat diagram. **[5]**

OR

6. a) Obtain an expression for electrical conductivity of an intrinsic semiconductor and comment on the variation of electrical conductivity with temperature. **[10]**

   b) The resistivity of pure silicon is 2350 Ωm and the mobility of electrons and holes in it are 0.135 $m^2V^{-1}s^{-1}$ and 0.048 $M^2 V^{-1} S^{-1}$ respectively. Find the electron and hole concentrations of a specimen of silicon doped with 10^{19} atoms of phosphorus per m^3. **[5]**

7. a) Derive an expression for contact electric field at the junction of a p-n junction diode. **[8]**

   b) Obtain an expression for transition capacitance (C_T) associated with the p-n junction. **[7]**

OR

8. a) With suitable diagrams, explain the construction and working of a silicon controlled rectifier. **[10]**

   b) Distinguish between BJT and JFET. **[5]**

9. Answer **any four** of the following : **[4 × 5 = 20]**

   a) Discuss the band structure of an electron in a 2-d lattice and show that the Fermi surface lies inside the first Brillouin zone.

   b) Show that the reciprocal lattice of a fcc is bcc.

   c) Calculate the electrical conductivity of copper if the Fermi energy and electron concentration of copper are 7.04 eV and 2.66×10^{28} m^{-3} respectively.

   d) Write a note on mean free path and its importance.

   e) Calculate the carrier concentration at 300 K for an intrinsic semiconductor with a band gap of 1 eV.

   f) Write a note on Gudden-Pohl effect.

   g) Find the value of applied voltage at 300 K for a p-n junction diode.

   Given: The saturation current $I_o = 32\ \mu A / cm^2$ and net current due to diffusion of charge carriers $I_F = 2.5 A / cm^2$.

   h) With a neat diagram explain the working of a relaxation oscillator.